Some Obſervations, Directions and Inquiries Concerning the Motion of Sap in Trees, in purſuance of what was formerly begun therein, about the latter end of 1668. and the next following Spring, by Dr Ezerel Tonge, *and* Francis Willoughby *Eſq;*

We ſhall here begin, according to the order of time, with the late Communications of D. Tonge, *which are as follows;*

I Now begin my Inquiries and remarks upon the laſt publiſht Obſervations of thoſe Ingenious perſons Mr *Willoughby* and Mr *Wray* in your *Ph. Tranſact.* N. 48. *June* 21. 1669. And *Firſt*, to the 3d and 4th Experiments I propoſe this Inquiry; At what Seaſon of the year, Month, day, and in what wind and weather, Branches and young Trees (eſpecially ſmall Branches) are ſo full of Sap, that being held perpendicular, they will bleed at both ends, as is there related; and Roots, both wayes? And what gage the Barometers and Thermometers then held? And in what forwardneſs their Buds and Leaves, or Chats were then ſhot, or broken? And of what Diameter ſuch Roots were?

The latter part of the 4th Experiment *appearing* ſo manifeſtly to diſagree with ſome Experiments, I have made this Year, as well as formerly, in Roots and Branches of Trees; whereby I found, that not only Cold weather, but Cold Wind and Sun-ſetting ſtopped or abated the Motion of Sap in the Sycamore: Which puzleth me, how to direct an Inquiry to find out the Cauſe of this ſingular Experiment, and of the Obſervations alſo in the 11th Experiment, which highly confirms this. The beſt directions I can at preſent deviſe, (untill the Experimenters ſhall pleaſe to give us an accompt of the Time, Seaſon, and that not only by the Month, day, hour, but alſo by the wind, and the motions of the weather-glaſs, before, after, and at the inſtant of thoſe Obſervations;) are the enſuing; which we ſhall conclude with ſome other inquiries.

1. What the difference of the Seaſons of that Experiment was from the foregoing? 2. Whether the *Heat* were ſo great, when the Sycamores ſo ſenſibly abated, that it coagulated their Juyce, and, by thickning it into Jelly and ſo into wood, ended the running? And therefore 3. Whether this Experiment of Cold, promoting, and of Heat, ſtopping the bleeding, were not in the later end of their running only, and not in the former? And if ſo, Whether 4, the riſing of Sap be not rather to be attributed to the *Degree* of heat, than the *Abatement* of *Heat*? 5. Whether the reaſon, that the *Birch* increaſed, when the *Sycamore* abated, be not alſo to be imputed to this, that the Birch runs not ordinarily till *March* (unleſs in a forward ſeaſon) and the Sycamore and leſſer Maple in *January*; and ſo the ſeaſon of the ones Sap, beginning ſooner, doth alſo end ſooner: And whether thereupon it be not obſerved, that the ſeaſon of the Birches Jellying into wood will not commence till a greater heat, as that of *May*; whereas the Maple-Sap probably will condenſe to Jelly and wood in a leſſer heat, as that of *March* going out, or *April* beginning? 6. Whether this be not alſo probably the reaſon of what is obſerved in the 12th Experiment in the ſame N.48. *viz.* the *Sycamores* running more on the *North*, and leſs on the *South*-ſide, contrary to my yeſterdayes Obſervation (*March* 1 16$\frac{69}{70}$,) the Southern branches yet dropping in the afternoon when others ceaſed? 7. Whether the *Birch* alſo in ſuch ſeaſons, after the *Maple* and *Sycamore* ceaſe running, will not bleed more in colder weather, ſuppoſe in the middle or beginning of *May*, or latter end of *April*, and ſo verifie my Experiment of the *Sycamore* running in hotter, and ſtaying in colder ſeaſons, or in the ſign *Piſces*, the latter end of *February*, and the beginning of *March*; and on the contrary, running in colder and ſtaying in hotter ſeaſons, *viz.* of *Aries* or the latter end of *March* and the beginning of *April*: Or briefly, In what *Signes*, and what weather as to wet and dry chiefly, the *Birch* and *Maple* bleed in hot, and ſtay in cold weather, *& vice verſa*? Which temper of weather I would have accurately obſerved by Weather-glaſſes and Barometers. 8. If this be found to verify my Conjecture, then Whether by the running and ſtaying of theſe Trees, and the firſt riſing and ceaſing of their Sap, may not probably (in ſome meaſure, by diligent Obſervation and comparing Ob-

ſervations of time, ſeaſon, weatherglaſſes,) be found the difference of Climats, Land, and *S*cituation; as alſo of Years forwardly or late fruitful, or of years unfruitful? 9. Whether the Obſervations of *Quality* as well as *Quantity* of *S*ap by Diſtillations after fermentation, &c. may not alſo conduce to the Prognoſtique of the Fruitfulneſs or Barrenneſs of a year, eſpecially in *Walnuts*, and ſuch Fruit-Bearers as yield plenty of *S*ap, and by analogy and obſervation from them to others: As (e. g.) whether a fruitful or unfruitful year of Hazel or Filbert-nuts may not probably be diſcovered by their *S*carlet-bloſſoms, not appearing this year till now? (*March* 2.) 10. Whether Ablaqueation (or digging about and baring the roots of Trees) will retard the riſing of *S*ap in the Walnut *&c.* and what other effect it will have on fruit, &c? And whether ſuch Baring of Roots of Pear, Plum and Cherry-trees (which are as much forwarder than Apples, as Maples are than Birch *&c.*) and generally of all forwarder Trees, ſhould not be made in different ſeaſons (accordingly) from Mulberries and ſuch like? 11. VVhether Amendment of ground, laid after the Sap ceaſeth, be not fruitleſs, as to that year, or much leſs beneficial than what is layd before? 12 Whether the ſeaſonableneſs of watering may not be found and promoted by a right Inquiry, and by a due ſatiſfaction to theſe Queries? 13. Whether Ablaqueation, watering, Amendment, &c, according to theſe ſeaſons, may not be ſo directed, as to encreaſe Fruit, Wood, or both, or either at pleaſure? 14. Whether Ablaqueation, which ſo alters the riſing of Sap, that it curdles them, when it ſhould run, doth not hurt? 15. Whether the ſame hath influx on the Leaves, Suckers and outward products of the Tree, or on the inward alſo, as fruit; or only increaſes their quantity, by accident hindring the growth and draught of other parts which did robb the fruit? 16. Whether the Cool ſeaſons of the Night afford not ſome temperament in theſe caſes, ſo that thereby, as tis in cool ſeaſons, the Sap runs and Jellies by day, as it runs by night? 17. Whether in ſome warm days, in which the *Sycamore* runs not at Noon or in the heat of the day, it run in the Night, or the Cool of the day, and, on the contrary, the *Birch* run by day or about Noon. and ceaſe at Night or Sun-ſet, in the ſame ſeaſons? 18. The ſame Queries might alſo be proſecuted in the Hop, which runs after the extream heat of the Summer, after the *Hops* are ripe and gathered, or any other Plant, that runs in Summer or Autumne, if there be any ſuch.

So far the Inquiſitive Doctor for this time: To which we cannot but ſubjoyn the Letter of that Worthy and Obſerving Gentleman, Mr. VVilloughby, *containing an Anſwer to ſuch of the precedent remarks and Inquiries, as concerned him, and therefore were imparted to him. It runs thus.*

*S*ir, 'tis no wonder; that Dr *Tonges* Experiments concerning the Bleeding of the *Sycamore* do not agree with ours, they being made in a different ſeaſon; his, in *February*, and ours towards the end of *March*, viz the Cold, which cauſed the Increaſe of the bleeding in the *Sycamore* and *Walnut*, hapned upon the 23. 24. 25. 26. *March*; and one *Sycamore*, which ceaſed to bleed from the 11th of the ſame Month, bled afreſh copiouſly from wounds that had been made ſo long before: The Buds before the cold were Juſt ready to open into Leaves, and the *Sap* had begun to coagulate above a fortnight before. This year, making inciſions in the *Sycamore* and common Maple, in *January*, immediately upon the relenting of the firſt Froſt, we found that they both bled, and faſter, as the weather grew hotter; nor did the ſucceeding Cold promote, but rather hinder their bleeding. *S*o that the Learned Doctor doth moſt ingeniouſly conjecture, that the Aſcent of *Sap* in Trees depends upon a certain Degree of heat, ſufficient to *raiſe*, but not to *coagulate* their reſpective Juyces. In thoſe Months, wherein the Heat *ordinarily* falls ſhort of that Degree, an accidental heat or warmth of weather promotes the bleeding; but in thoſe Months, wherein the ordinary temper of the Air exceeds that Degree, an extraordinary fit of colder weather makes them bleed again.

The Experiments concerning the *Northern* and *Southern* ſides of *Sycamores* were made at the ſame time; and are well ſolved by the ſame *Hypotheſis*.

In *Walnut*-trees, we never yet found, that Heat promoted their bleeding, but always Cold. From a wound, made in a *Walnut*-tree, in *January*, and the beginning

of

of this preſent *March*, in mild weather, nothing iſſued; but the weather changing and growing colder, it bled plentifully: Which ſeems not well to conſiſt with that Hypotheſis, and muſt be better examin'd.

Laſt year, the 6th and 7th of *March* we made the Experiments of the Bleeding of Poles (held perpendicular) at both ends, in Willow, Birch, and Sycamore: which may ſo eaſily and certainly be found to ſucceed, in a great latitude both as to the bigneſs of the boughs and temper of the weather, in the beſt Bleeding ſeaſon, that there needs no ſuch exact niceneſs in the Obſervation of thoſe particulars. The 11th of *March*, Roots of Birch, great and ſmall, bled both ways; and about the ſame time, Sycamore roots alſo. Of all which I doubt not, but Dr *Tonge* is by this time fully ſatisfyed by his own Experiments. The ſame Birch, which firſt began to bleed the 3d of *March* this Year, bled 3 weeks ſooner laſt year.

Tryal would be made, whether Cold will diſſolve the Sap already coagulated: Elſe it will be hard, in the Doctors Hypotheſis, to give an accompt of the Trees dropping a new in Cold weather.

It was laſt Autumne obſerv'd by our ingenious Friend Mr *Martin Liſter*, that upon the firſt Froſt, which hapn'd in *November*, a Sycamore bled copiouſly; ſo that the Sap cannot be ſaid to riſe in *January*, but immediately after the Fall of the leaf, in this Tree.

Our Experiments, which you have already printed, are moſt true, and according to the Doctors Hypotheſis, will very well agree with his. His Deductions and Inquiries are very rational and well deſerve to be made publick. Various interruptions have hindred us from the diligent proſecuting of theſe Experiments this *Spring*; which that I may more critically make hereafter, I muſt procure two Sealed Thermometers and two Barometers. I am &c. Dat. Middleton in Warwick-ſhire *March* 12. 16$\frac{69}{70}$.

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